

**Final Progress Report**  
**Sustainability Science Program**  
**Term: September 1, 2013 – August 1, 2014**

**Name:**  
Alicia Harley

**Your fields:**  
Public Policy, Innovation Studies, Political Institutions, Science and Technology Studies, Organizational Behavior

**Your degree program, institution and graduation date:**  
PhD Candidate Harvard Kennedy School of Government, expected May 2016

**Faculty hosts at Harvard name and department:**  
William Clark, Harvard Kennedy School  
Missy Holbrook, Department of Organism and Evolutionary Biology

**Description of SSP-related research activity:**

- My main SSP related activity is working on my dissertation:
  - **Agriculture Innovation for Small and Marginal Farmers Farmers: A Regional Study of Bihar, India**
- I have a second project in India, which is a comparative study of the micro-irrigation subsidy systems across 4-6 States. I am interested in how the intuitional design of State-specific systems for administering the subsidy scheme leads to different rates of adoption and differential access to the technology by small and marginal farmers.
- In addition, I am co-organizing a conference with Professor Missy Holbrook
  - **Innovation with Access to Technology for Vulnerable Farmers: The Innovation System for Drought and Water Scarcity Adaptation Technologies**
  - This conference will take place September 10-12 2014 at Harvard University
- I am also continuing as the Agriculture Sector Lead for the Project on Innovation and Access to Technologies for Sustainable Development.
  - Our main output this semester has been a synthesis paper for the project as well as a workshop report. The link to the synthesis paper is here:  
<http://www.hks.harvard.edu/centers/mrcbg/programs/sustsci/documents/papers/2014-01>
  - I am also working on finalizing the agriculture sector background paper and the case studies for publication on the website.
- Project lead for the 2013-2014 Agriculture Innovation Initiative
  - Project: **Improving agriculture services for the poor and marginal farmers: A Comparative Study of Brazil and India**

**Abstract:**

I am studying the agriculture innovation system in Bihar India, with a specific focus on the role of the innovation system in improving the livelihoods of vulnerable farmers. This is my doctoral dissertation project and is thus a multi-year project. I am conducting intensive fieldwork for this project as a non-resident SSP fellow between July 2014 and September 2015. I received the Frederick Sheldon Traveling Fellowship from Harvard to complete this research project.

**Research Abstract: Agriculture Innovation for Small Farmers: A Regional Study of Bihar, India**

In the agricultural sector, innovation is a central strategy to achieve economic, social and environmental goals (Ruttan 2001), yet agriculture innovations are often not reaching the most vulnerable members of the agriculture system who need them most—small and marginal farmers (Kristjanson et al. 2009). This is a

problem-driven basic research question (Stokes 1997), motivated by the too often neglected question of how agriculture innovation systems can better serve the needs of vulnerable farmers, and considers the extent to which findings from current literatures on innovation are robust and relevant for understanding agriculture innovation to meet the needs of vulnerable populations.

### **Identification of the problem you address:**

For much of the 20th century, the agriculture development community thought it had solved the problem of agriculture innovation for development: Known as the transfer of technology model (TOT), universities and governments would fund and conduct basic R&D, the private sector would do applied research and product development, and local governments would fund extension services bringing agriculture knowledge and technology to farmers (Biggs 1990). While this model led to increased yields during the Green Revolution in many areas of the world, it also resulted in significant unintended consequences including environmental externalities and increased inter- and intra-regional socioeconomic inequality (Pingali 2012). Problems with the TOT model were identified in the 1980s, with the recognition that farmers needed to be better integrated into the innovation system to ensure more appropriate technologies (e.g. Bunch 1982; Chambers et al. 1989; Okali et al. 1994; Scoones and Thompson 1994). But 30 years after the publication of this literature, farmers in much of the developing world have not benefited from modern agriculture innovations and in many ways the challenges today are more complex than they were during the 20th century (Scoones & Thompson 2009). A new approach to agriculture development, which builds on appropriate technology literatures, but also incorporates insights from innovation systems theory across a number of disciplines and sectors, is required to address the challenges faced by vulnerable farmers today.

### **Key question asked about the problem:**

- How do agriculture innovation systems address the needs of the most vulnerable farmers?
- What are the major barriers in agriculture innovation systems to address the needs of vulnerable farmers?
- Do current theories in innovation studies, and agriculture innovation studies in particular adequately capture the challenges of innovation for vulnerable farmers?
- Do mechanisms identified in innovations studies literature function the same way for vulnerable farmers that they do for farmers in general? The policy relevance of this question is what in particular do we need to worry about when supporting innovation for vulnerable farmers that current understandings of innovation might overlook.

### **The methods by which you answered that question:**

**Methods:** My study relies largely on ethnographic methods to understand the complex dynamics between different stages of the innovation system, actors & organizations, institutions and the socio-technical characteristics of agriculture technology in Bihar. Using ethnography as an inductive approach to theory building, I will investigate “constructs” based on findings and hypotheses from multiple literatures about different aspects of agriculture systems in order to explore the extent to which these constructs confirm, reject or complexify current theory (Glaser & Strauss 1967). My intent is to explore these constructs across each stage of the innovation process in order to discover the extent too which constructs are relevant in Bihar’s innovation system; where and how in the innovation system these constructs matter; and most importantly what aspects of innovation systems theory need to be amended when it comes to understanding innovation to meet the needs of vulnerable farmers.

The theoretical leverage that this structural approach to the innovation provides is a methodology for interrogating my data by locating where in the innovation system different enablers and barriers of innovation are important and the mechanisms that underlie both enablers and barriers to innovation for vulnerable farmers. Some of the literatures I will draw from include: Induced innovation, public goods, market failure, and collective action. For example, the theory of induced innovation (Hayami & Ruttan 1984; Ruttan 2001) posits that new technology is produced in response to demand forces stemming from changes in relative factors of production such as changes in market prices, labor costs or availability of natural resources. In Bihar, I will study to what extent the theory of induced innovation explains processes

of knowledge and technology development and specifically if induced innovation mechanisms operate for vulnerable farmers in the same way they do for farmers in general.

In addition to ethnographic methods, the study will incorporate a quantitative approach. By triangulating findings using the strengths of different research methodologies, mixed methods research provides a degree of analytic leverage that no single approach can achieve (Jick 1979). In particular, I want to conduct a quantitative survey in Bihar that solicits farmer perceptions of different actors and organizations engaged in knowledge and technology support functions for farmers. I will use variety of hypotheses identified in the literature for successful agriculture extension practices to construct survey measures (*e.g.* Cash et al. 2002; Reid et al. 2009; Clark et al. 2011) and randomize part of the survey with different scenarios in order to make causal inferences about what vulnerable farmers believe determines successful models of knowledge support service provision.

### **Principle literature upon which the research drew:**

**The study engages with and goes beyond recent literature in three distinct ways:** **First:** the study will employ a structural systems perspective that looks at agriculture innovation in Bihar across multiple non-linear stages including: *invention & selection* of knowledge and technology through *promotion & adoption* and finally *adaptation & widespread use*. Currently, too much of the literature on agriculture innovation treats the processes of innovation as an amorphous black box, instead of a complex structure that can be described and modeled. My research in contrast, by focusing on the relationships and feedbacks between stages of the innovation system will offer greater clarity into the mechanisms and barriers to innovation for vulnerable farmers. The inductive model of the innovation system employed in this project is based on case study research conducted by the author in conjunction with a team of scholars at Harvard between 2011 and 2013 as part of a project on Innovation and Access to Technologies for Sustainable Development across a range of sectors including water, energy, agriculture and manufacturing.<sup>1</sup>

**Second:** The research will focus specifically on the ability of the innovation system to serve the needs of some of the most vulnerable members of the system—small and marginal farmers. The challenges created by inevitable power asymmetries in innovation systems have been underexplored both in innovation studies broadly and agriculture innovation systems literature in particular. How do power asymmetries inherent in any innovation systems—but perhaps especially so within agriculture innovation systems—lead to barriers in the innovation system to achieve benefits to the most vulnerable members? The lack of focus on power asymmetries in agriculture innovation studies has repercussions on agriculture development practice, because questions of equity are often left off the table. This unique focus will integrate an extensive literature on power (*e.g.* Gaventa 2003; Jasanoff 2004; Callon 1999; Latour 1997) into innovation studies and provide a more robust set of conceptual tools for thinking about power asymmetries in innovation systems.

**Third:** Innovation systems literature to date focuses on actors and institutions in the innovation system at the neglect of characteristics of the technologies themselves. This project will employ a more complex understanding of knowledge and technology that posits that technology must be understood in relation to social systems (*e.g.* Callon 1999, Jasanoff 2004) and that technological change and social change are firmly intertwined, so that we cannot fully understand either social or technological systems without reference to the other. This opens up the question of whether socio-technical characteristics of technology are inherently political. Framed another way, can technologies be studied and judged not only for their contributions to efficiency and productivity, or for their ability to reduce labor requirements, or even for their environmental externalities, but also for the ways in which different technologies embody and reproduce specific forms of power and authority (Winner 1980)? This line of inquiry—especially in a study focusing on vulnerable farmers—opens up for examination the relationship between power and factors driving the innovation of specific technologies and knowledge systems over others.

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<sup>1</sup> This model was created by the Project on Innovation and Access to Technologies for Sustainable Development: <http://www.hks.harvard.edu/centers/mrcbg/programs/sustsci/activities/program-initiatives/innovation>. I have included a figure of the model in my research timeline. I was the lead investigator for the agriculture sector in this project.

### **Empirical data acquisition description:**

Bihar is an excellent location to investigate this topic for a two reasons: **First**, agriculture employs 75% of the labor force, with 93% of farmers classified as small or marginal, making vulnerable farmers critical to Bihar's social and economic progress and a key priority for leaders in the State. **Second**, Bihar's agriculture innovation system is undergoing rapid change especially since the election of the current Chief Minister, Nitish Kumar, in 2005. The recent changes in the agriculture system in my initial interviews provided important analytic leverage—subjects can easily speak about changes that have taken place since 2005, and often speak in a *before-and-after* Nitish Kumar framework. This provides analytical traction through a qualitative “time discontinuity” for reflection on the impacts of these changes on the agriculture innovation system.

### **Fieldwork Timeline: July 2014 - September 2015**

1. I will spend almost all of my time in Bihar. I will be based out of the capital city, Patna, but I will also select a single village where I will do an in-depth case study. I will have a rented room in this village so that I can immerse myself in the village for weeks at a time. I selected this village in July 2014. The name of the village is confidential to project my research subjects.

In addition to the village level case study, I will travel extensively in rural areas for day trips and extended stays. I will gain access by working with different organizations involved in innovation in Bihar, many of which have already expressed support for my research.

2. I will use the innovation systems model (see figure 1), to investigate findings and hypotheses from innovation systems literatures as well as emergent findings from my own fieldwork. I will use the model to ask at what stages do different hypotheses in the literature play a role in the innovation system as well as to the extent to which these hypotheses are relevant or should be revised when looking specifically at innovation for vulnerable farmers.
3. I will use an iterative research strategy between fieldwork and data analysis. This will entail a cycle of approximately 10 days of intensive fieldwork, followed by 5 days of writing and reflection. I will rely on ethnography and grounded theory methods for qualitative fieldwork, which explicitly recommend this kind of iteration between fieldwork and analysis.
4. During this time, I hope to supervise survey a data collection (using local survey enumerators) and perform some analysis on the data to ensure it is robust.<sup>2</sup> I will leave time-consuming statistical analyses for my return to the United States, as I want to focus my time on fieldwork while I am in India.

### **Geographical region studied:**

My research focus is Bihar, India for my dissertation project.

I have a second project on drip irrigation that is comparative across six states that I also hope to complete through short visits over the course of the year.

### **Recommendations that might be relevant for your problem:**

Preliminary Findings: 1. Collective action is key driver of innovation that serves the interests of vulnerable farmers—For vulnerable farmers, collective action is particularly important for improving their power in the innovation system (from improving access to inputs, to collectively marketing their products, to asking researchers for more appropriate technologies). 2. The current subsidy system is inaccessible to vulnerable farmers—While the government reserves 20% of subsidies for vulnerable farmers, much of this money stays in government accounts due to a lack of programs and institutions to promote access. 3. Integrating

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<sup>2</sup> I hope to get external funding to pay data enumerators, using grants that specifically fund survey collection, but explicitly DO NOT fund the type of long-term qualitative fieldwork I propose here. I have applied to the International Growth Center (IGC) for survey support and will submit funding applications to other programs that support agriculture surveys.

knowledge and technology promotion with supply chain access is critical— Knowledge support services are most successful at supporting knowledge and technology adoption by vulnerable farmers when they also help farmers overcome barriers of access to supply chains.

**A description of the final product(s) you have/are aiming to produce:**

- I hope to publish a book and several journal articles based on my dissertation research. This is a longer-term project that will culminate with my intended graduation date in June 2016 but any book project would probably require another year of work before publication.
- Other forthcoming projects include:
  - Co-author: Innovation and Access to Technologies for Sustainability Synthesis Paper (Diaz Anadon et al) and potentially lead author on a chapter of the book that will be the final product of this initiative (Anadon, Matus, Moon).
  - Co-author: Paper on comparative knowledge support services across India, Brazil and other countries. This will be the product of the 2013-2014 Innovation and Access Project. (Clark, Harley, many others)
  - Co-author: Several qualitative and quantitative papers on drip irrigation adoption.
    - The qualitative paper comparing the drip irrigation innovation system in Israel, India, Ethiopia and the Western Sahel is near completion (Friedlander, Harley)
    - In conjunction with other colleagues, we received a grant from IGC for conducting a survey on drip irrigation adoption in Gujarat and Andhra Pradesh, which will hopefully result in several co-authored publication (Fishman, Harley, others)
  - Co-author: Innovation with Access to Technology for Vulnerable Farmers: The Innovation System for Drought and Water Scarcity Adaptation Technologies. This paper will hopefully result from our spring 2014 conference on this topic. (Holbrook, Harley, others..)
  - Co-author forthcoming: Towards a second GR in Africa—Innovation Systems for Reflexive Agriculture Development. (Harley, Hellin, Pereira)
  - Proposed co-author paper/white paper: Agriculture Innovation Framework Paper that links our framework on innovation **with access** with the conceptualization of sustainability as inclusive wellbeing.
  - Potential co-authored paper: Impacts of SRI on socioeconomic inequality based on a panel data set and a RCT that I would do in conjunction with Ram Fishman. (Harley, Fishman)
  - Authored: Quantitative paper on KSS in Bihar based on measures for saliency, credibility and legitimacy (Harley)
  - Authored: Paper on SRI in Bihar
  - Authored/co-authored: Paper Evaluating the Green Revolution for its contribution to inclusive human wellbeing.

**Description of major other intellectual or professional advancement activity(ies) over the past academic year:**

PhD Qualifying Paper: Agriculture Innovation for Vulnerable Farmers: A Regional Study of Bihar, India

**Please list citations for reports, papers, publications and presentations that built on your fellowship research:**

**Working Papers**

- Laura Diaz Anadon (*Harvard Kennedy School*), Kira Matus (*London School of Economics*), Suerie Moon (*Harvard School of Public Health*), Gabriel Chan (*Harvard Kennedy School*), Alicia Harley (*Harvard Kennedy School*), Sharmila Murthy (*Suffolk University Law School*), Vanessa Timmer (*One Earth*), Ahmed Abdel Latif (*International Centre for Trade and Sustainable Development*), Kathleen Araujo (*Harvard Kennedy School*), Kayje Booker (*Forward Montana*), Hyundo Choi (*Chosun University*), Kristian Dubrawski (*McKinsey*), Lonia Friedlander (*Stony Brook University*), Christina Ingersoll (*MIT Sloan*), Erin Kempster (*Massachusetts Department of Public Utilities*), Laura Pereira (*University of Cape Town*), Jennie Stephens (*Clark University*), Lee Vinsel (*Stephens*)



*Institute of Technology*), and William C. Clark (*Harvard Kennedy School*) <  
<http://www.hks.harvard.edu/centers/mrcbg/programs/sustsci/documents/papers/2014-01>>

- Harley et al. 2013. Agriculture Innovation Systems Background Paper; HKS White Paper, Forthcoming
- Friedlander and Harley, 2014. Drip Irrigation Innovation Systems in Africa and India, HKS Working Paper for Project on Innovation and Access to Technologies for Sustainable Development. Forthcoming.
- Case Study: System of Rice Intensification, for Project on Innovation and Access to Technologies for Sustainable Development. Forthcoming.
- Harley, Holbrook, Clark. Background Paper for Workshop on Innovation for Vulnerable Farmers

## Talks

- Weatherhead Center for International Affairs Graduate Student Seminar , *Harvard, November 2013*
- Sustainability Science Seminar Series: Agriculture Technology and Inequality, *Harvard, October 2013*
- Invitation from Drew Faust as COUR Panel Discussant: Food for Thought, *Harvard April 27, 2013*
- WCFIA Faculty Dinner Series: Agriculture Innovation Systems, *Harvard Fall, 2012*

**Please describe any collaborative activities with other SSP Fellows that you are involved with.**  
**Improving agriculture services for the poor and marginal farmers: A Comparative Study of Brazil and India**

- This project is the main collaborative project of the Innovation Initiative for 2013-1014
- **Project Team:**
  - William Clark (PI)
  - Alicia Harley (Project Lead)
  - Judson Valentim: judson\_valentim@hks.harvard.edu
  - Pamela Templer: ptempler@bu.edu
  - Nathan Mueller: nmuellet@fas.harvard.edu
  - Yosef Manik: yosef\_manik@hks.harvard.edu
  - Rachael Garrett: Rachael\_Garrett@hks.harvard.edu
  - Rob Paarlberg: Robert\_Paarlberg@hks.harvard.edu
  - Calestous Juma: calestous\_juma@harvard.edu

## **Abstract:**

This working paper looks at the hypothesis that agriculture innovation systems favor larger farmers in Brazil and India. We study the services provided by different actors in the public, private and civil society sectors in order to understand their impact on the poorest and most vulnerable farmers. We conclude with policy recommendations based on the experience of these two countries for actions actors can take to improve the access of the poorest and most marginal farmers to knowledge and technology. In **section II**, we propose a conceptual model of the innovation system, which we employ as a common framework for the comparative analysis of Brazil and India and situate this framework within the larger literature on agriculture knowledge systems and efforts to theorize the challenge of linking knowledge with action in agriculture development scholarship. In **section III**, we explain out methodology for the study. In **section IV** we look at the broad shape of the agriculture system in Brazil and India. In **section V** we describe the agricultures services in each the country, including current efforts in research, development, demonstration, and extension, and the roles of public, private and civil society actors in delivering these services. In **Section VI** we use the

conceptual model of the innovation system as a structure through which to compare and gain analytic traction over the impacts actors in each countries innovation system are having on the poorest and most marginal farmers. **Section VII** concludes with key findings and policy recommendations for improving the wellbeing of the smallest and most marginal farmers by changing the ways in which actors in the agriculture innovation system operate.

## **Innovation with Access to Technology for Vulnerable Farmers: The Innovation System for Drought and Water Scarcity Adaptation Technologies**

### **CO-CONVENERS:**

- Missy Holbrook, Harvard University, Professor of Biology and Charles Bullard Professor of Forestry, Department of Organismic and Evolutionary Biology
- Alicia Harley, PhD Candidate Harvard Kennedy School of Government, Giorgio Ruffolo Doctoral Research Fellow in Sustainability Science, Weatherhead Center for International Affairs Graduate Student Associate

Two-day conference beginning the evening of April 30<sup>th</sup> and concluding the afternoon of May 2<sup>nd</sup> 2014 with the purpose of convening the academic community and practitioners to discuss the challenges facing drought and water scarcity adaptation technologies for vulnerable farmers. The focus on vulnerable farmers in this conference is a specific and conscious attempt to provide an opportunity to move the dialogue around water and agriculture away from questions of yield or water use efficiency and towards the challenge of serving the needs of the most vulnerable members of our global agricultural system.

The conference will employ a framework of innovation with access (forthcoming) developed at the Initiative on Innovation and Access to Technologies for Sustainable Development at Harvard University's Sustainability Science Program. An innovation with access approach provides a conceptual framework for studying the innovation system, which places important emphasis on the importance of adoption, adaptation and sustained use in order to realize benefits—improved human wellbeing—for vulnerable farmers. We will employ this framework to frame our discussion of drought adaptation technologies for vulnerable farmers including biotic, manufactured and practice based technologies as well as larger institutional innovations.

The purpose of the conference is to bring together the natural and social scientific communities along with practitioners to address the challenges facing the innovation system for drought resistant and water saving agriculture technologies for those who need them most—small and marginal farmers.

### **Principal collaborators outside Harvard (list name and institution):**

- **Jon Hellin**, Senior Scientist CIMMYT, CGIAR
- **Laura Pereira** (Dphil Oxon) is currently a post-doctoral research fellow at the University of Cape Town where she is working on a project looking at orphan crop innovation, Former SSP Fellow
- **Ram Fishman**, Assistant Professor of Economics George Washington University, Former SSP Fellow
- **Avinash Kishore**, Senior Researcher, IFPRI Delhi, CGIAR
- **Lonia Friedlander**, PhD Student Stony Brook University, Connecticut
- **Aditi Mukherji**, Theme Lead, ICIMOD, Nepal, [amukherji@icimod.org](mailto:amukherji@icimod.org)
- **Lonia Friedlander**, PhD Student Stony brook University, [loniarf@gmail.com](mailto:loniarf@gmail.com)
- **Sahil Gulati**, Consultant World Bank India, [sahilgulati4@gmail.com](mailto:sahilgulati4@gmail.com)

**List any awards or grants that you have received this year for the current or coming year:**

- Frederick Sheldon Traveling Fellowship, for dissertation fieldwork during the academic year of 2014-2015 in Bihar, India; \$24,000
- Weatherhead Center for International Affairs Summer Language Study, Hindi, \$6,000
- Weatherhead Center for International Affairs Research Grant, Travel to India, \$2,600
- Ideas for Growth, India, Survey Research Funding, co-recipient for drip irrigation survey in India, \$25,0000

**If you are moving to a new position, please list your contact information there:**

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